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1990 Weed Management Guide

FOR COMMERCIAL VEGETABLE GROWERS

WEED MANAGEMENT requires a multifaceted approach, built upon an understanding of weeds and the crop. Weed management may involve nonchemical (organic) methods, chemical (herbicides) methods, or a combination of the two. The decision on which methods to use depends on environmental concerns, marketing opportunities, desired management intensity, labor availability, weed pressure, and the crop.

The first step in weed management is to identify the weeds and understand their life cycles. Consult identification guides, such as *Weeds of the North Central States* (NCR Research Publication No. 281, College of Agriculture, University of Illinois at Urbana-Champaign) for assistance. Weeds can be categorized by life cycles, and management strategies developed accordingly. Annual weeds complete their life cycles in one year and reproduce solely by seeds. Annuals can be divided into summer or winter annuals depending on when they grow. Primary tillage operations often control winter annuals before a crop is planted in the spring. The most common vegetable crop weeds (i.e., barnyardgrass, giant foxtail, common purslane, redroot pigweed, and common lambsquarters) are summer annuals. Mechanical and cultural weed management methods help in suppressing summer annuals. Perennial weeds live for more than two years and can reproduce by seed or vegetative structures (stolons, rhizomes, corms, bulbs, tubers, or roots). Because perennial weeds are impossible to manage in vegetable crops, it is usually better not to use a field with severe perennial weed problems.

This revision features three sections: nonchemical weed management strategies, chemical weed management strategies, and environmental and health hazards of herbicides. Many nonchemical weed management methods are commonsense farming practices. These practices are of increasing importance due to consumer concerns about pesticide residues, potential environmental contamination from pesticides, and unavailability of many older herbicides.

Nonchemical Weed Management Strategies

Weed management should start with nonchemical strategies that reduce problems caused by weeds. Their aim should be to manage the weed population so it is below a level which will cause a reduction in your economic return (economic threshold). In some instances, the cost of controlling weeds may be more than the economic return obtained from any yield increase. This situation occurs when a few weeds are present or the weeds germinate late in the season. In those instances, the best strategy may be to do nothing. In other situations weed populations and other considerations may require combining herbicides with nonchemical approaches.

Cultural Practices

You should aim to establish a vigorous crop that competes effectively with weeds. This starts with your *land selection.* A general rule is not to plant vegetables on land with a history of heavy weed infestation, especially perennial weeds. *Crop selection* can reduce the effects of weed competition. The crop selected should depend on the weed problems of the field. Plant the most competitive crops in the most weed-infested fields and the least competitive crops in the cleanest ones. Consider planting heavily infested fields as long-term set-aside acres or in nonrow crops such as alfalfa. Permanent cover should prevent buildup of annual weeds.

Crop rotation is another practice which can reduce weed problems. The characteristics of the crop, the methods used to grow it, and the herbicides used inadvertently allow certain weeds to escape control. Rotation also affects the weed management tools at your disposal. Rotating between crops will improve growth and the crop's competitiveness.

A number of different rotations can be used, but some general observations have been made. Legumes, onions, and squash are beneficial, while carrots, beets, and cabbage are detrimental as preceding crops. Also, related vegetables should not be grown in the same location in successive years. Table 1 lists related vegetable crops.

Wild proso millet is an example of a problem weed where rotation is important for management. Rotating from sweet corn to small grains, early-planted peas, or alfalfa almost completely eliminates wild proso millet. Alfalfa, early-planted peas, and small

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Table 1. Botanically Related Vegetables

Corn	*Cucurbits*	*Crucifers*	*Legumes*
Sweet Corn	Winter squash	Rutabaga	Soybeans
Dent Corn	Summer Squash	Kale	Peas
Onions	Pumpkin	Broccoli	Snap Bean
Onion	Muskmelon	Cauliflower	Lima Bean
Garlic	Watermelon	Cabbage	Dry Bean
Spinach	*Solanaceous*	Brussels Sprout	
Beets	Potato	Radish	
Chard	Tomato	Horseradish	
Spinach	Pepper		

grains establish before the soil is warm enough for wild proso millet to germinate. Rotating from sweet corn to broadleaf crops allows postemergence grass herbicides to be used to manage wild proso millet.

Once a crop is selected use *adaptive vigorous varieties* resistant to diseases. Disease-infested plants cannot effectively compete with weeds. Varieties suited for cultivation in Illinois are listed in *Vegetable Varieties for Commercial Growers* (Circular 1174, University of Illinois at Urbana-Champaign, Cooperative Extension Service).

Narrower row spacings and proper plant densities assure the crop rapidly closes canopy. A closed canopy shades out later emerging weeds and prevents weed seeds requiring light from germinating. Weeds seldom are a problem once canopy closure occurs. Proper row spacing and plant density also allow row cultivation.

Another cultural method to improve crop competitiveness is to use the *correct planting time.* Crops can be divided into warm- or cool-season plants depending on the optimum temperature for their growth. Planting date affects the time to emergence and early seedling vigor of the crop, which are important in determining crop competitiveness. Cool-season crops germinate at cooler soil temperatures and thus compete better against early emerging weeds than warm-season crops. Table 2 lists crops according to their adaptation to field temperatures. Time plantings so that temperatures are favorable for crop growth.

Adequate fertilization and appropriate insect and disease management are important in assuring a competitive crop. Adequate fertility assures rapid, uniform germination and good crop growth, which enhance the crop's competitive ability. For information on fertility, consult *Fertilizer Guide for Commercial Vegetable Growers* (Circular 1185, University of Illinois at Urbana-Champaign, Cooperative Extension Service). Disease management information is contained in *1990 Disease Management Guide for Commercial Vegetable Growers* (Circular 1184, University of Illinois at Urbana-Champaign, Cooperative Extension Service) and insect management information is in *1990 Insect Pest Management Guide: Commercial Vegetable Crops* (Circular 897, University of Illinois at Urbana-Champaign, Cooperative Extension Service). While poor insect and disease control reduce a crop's competitiveness, inadequate weed control can also cause insect and disease problems.

Table 2. Classification of Vegetable Crops According to Their Adaptation to Field Temperatures

Cool-Season		Warm-Season	
Hardy*	Semi-Hardy	Tender	Very Tender
Asparagus	Carrot	Snap Bean	Cucumber
Broccoli	Cauliflower	Sweet Corn	Eggplant
Cabbage	Chinese Cabbage	Tomato	Lima Bean
Horseradish	Lettuce		Muskmelon
Onion	Potato		Okra
Peas			Pepper
Spinach			Pumpkin
			Squash
			Watermelon

*Hardy crops are most tolerant of cool temperatures and frost, while very tender crops are most susceptible to frost and cool temperatures.

Mulching can be useful in managing weeds. Mulches can be classified as either organic (i.e., straw, leaves, paper, and compost) or plastic sheets. Because organic mulches are difficult to apply over large areas, they are best for small specialized areas. Organic mulches should be spread evenly at least 1-1/2 inch thick over the soil to prevent light penetration. Organic mulch materials must be free of weed seeds and other pest organisms and be heavy enough so they will not be easily displaced by wind or water. A major advantage of organic mulches is that they add organic matter to the soil.

Plastic mulches are easy to apply, control weeds within the row, conserve moisture, and increase soil temperature. Black plastic mulches are the most common. Plastic mulches are particularly effective in improving early-season crop growth of warm-season crops such as tomatoes, muskmelons, watermelons, or peppers. Plastic mulches used in combination with trickle irrigation improve water use efficiency.

The biggest disadvantage of plastic mulch is disposing of the plastic. Many landfills do not accept plastic mulches. Photodegradable plastic mulches have been developed, but their season-long persistence has been a problem. Photodegradable mulches also degrade into small pieces of plastic that contaminate the environment. Biodegradable plastic mulches are not yet widely available.

Mechanical Practices

Mechanical weed management relies on primary and secondary tillage implements such as the rotary hoe and the row cultivator. Mechanical weed management starts with seedbed preparation. Few no-till systems have been developed for vegetable crops. No-till suggestions are included in the section on herbicides.

Moldboard plowing is usually the first step in mechanically managing weeds. Moldboard plowing is particularly useful in controlling emerged annual

weeds. *Rotary hoeing* is often an important second step in mechanically managing weeds in large-seeded vegetable crops (i.e., sweet corn, snap beans, lima beans, and peas). Rotary hoeing needs to be done after the weeds germinate but before they emerge. Large-seeded weeds, such as velvetleaf and shattercane, will not be controlled by rotary hoeing.

Once the crop has emerged or transplants are established, a *row cultivator* can be used to manage emerged weeds. Adjust the cultivator sweeps or teeth to dislodge or cover as many weed seedlings as possible. Seedling weeds can be killed by cultivating 1 to 2 inches deep. Best weed control is obtained using a row cultivator in relatively dry soils and throwing soil into the crop row to cover small weed seedlings. Avoid crop injury from poor cultivation, which will reduce crop yields.

In some vegetable crops, such as asparagus, *mowing* can be an effective weed management tool. Mowing can prevent the production of weed seeds and kill upright weeds, reducing competition. Mowing must be carefully timed to prevent the production of viable seed. Mowing may favor low-growing or biennial weeds by reducing competition from upright plants. Timely repeated mowing also helps deplete the food reserves of perennial weeds.

Mechanical control has a number of limitations that must be considered when designing weed management systems. Mechanical management relies on relatively dry weather, and a rainy period may eliminate mechanical management options and lead to severe weed competition. Relying entirely on mechanical practices to manage weeds is difficult on large acreages. Also, several weeds are extremely difficult to manage unless herbicides are combined with nonchemical approaches. Some of the problem weeds include wild proso millet in sweet corn, Canada thistle, hemp dogbane, field bindweed, quackgrass, and johnsongrass. Newly introduced problem weeds often show up in scattered patches along headlands and field borders. These are best controlled or eradicated with herbicides before large areas are infested.

Biological Practices

Currently no systems exist in the Midwest using insects or diseases to control weeds common to vegetable crops. Most biological management systems using diseases or insects to control problem weeds have centered on rangeland areas in the West. One biological system that has potential in the Midwest is the use of cover crops to suppress the development of weeds. These systems are still experimental, and problems have been encountered. The problems include the duration of weed control from cover crops and the spectrum of weeds controlled. Herbicides are often required to kill the cover crop and to manage any emerged weeds. Overall, cover crop systems tend to control small-seeded annual broadleaf weeds the best. The most promising cover crop system is winter rye. Winter rye is planted in the late summer or early fall; the rye is killed in the spring with Roundup or Poast; and the crop is no-till planted. The system is experimental and should be evaluated in small areas before extensive use.

Table 3 summarizes some of the nonchemical weed

Table 3. Summary of Nonchemical Weed Management Practices

Practice	Comments
Cultural	
1. Land selection	Avoid fields with history of weed problems.
2. Crop selection	Grow the most competitive crops in fields with history of weed problems.
3. Crop rotation	Rotate between vegetables and non-row crops such as alfalfa. Rotate between vegetables in different botanical categories.
4. Adapted crop varieties	Select crop varieties adapted for your area.
5. Proper row spacings and plant densities	Use row spacings and plant densities that assure rapid crop canopy closure.
6. Correct planting times	Plant crops when soil temperatures favor rapid germination and emergence. Do not plant warm-season crops too early in the season.
7. Appropriate fertility, disease and insect management	Vigorous, healthy crops are more competitive against weeds.
8. Mulch	Organic mulches are difficult to use over large acreages. Plastic mulches are useful to manage weeds within the row in warm-season crops. Consider disposal problems when using plastic mulches.
Mechanical	
1. Moldboard plowing	Can eliminate emerged annual weeds.
2. Rotary hoeing	Useful to manage small-seeded weeds in large-seeded crops such as sweet corn, snap beans, lima beans, and peas.
3. Row cultivator	Dislodge or cover as many weed seedlings as possible. Avoid damaging crop root systems.
4. Mowing	Mow weeds as soon as flowers appear so no viable weed seed is produced.
Biological	
1. Cover crops	Still experimental. Winter rye system is the most promising — most effective against small-seeded broadleaf weeds.
2. Insect or disease pests of weeds	No current systems use insects or diseases to manage weeds common to vegetables.

management practices. An integrated approach should be used which combines many different practices to manage weeds. This approach must be adaptive, aiming to prevent weed problems or cope with any that occur.

Chemical Weed Management Strategies

The University of Illinois and its agents assume no responsibility for results from the use of herbicides, whether or not they were used in accordance with suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Several herbicides are often labeled for a crop. Scouting your area to determine which weeds are present will allow you to select the herbicide that will give you the best control. Potential environmental hazards must be considered when selecting a herbicide. Herbicide labels contain information on these hazards. The last section of this publication also discusses potential environmental hazards.

All the herbicides labeled for a crop are not necessarily listed below. Also, because revisions may change some herbicide uses, always read and follow carefully the directions on a current herbicide label before using any product. If you are unfamiliar with a herbicide, conduct a small test under your environmental conditions and cultural practices before using the herbicide extensively.

Always Read and Understand the Herbicide Label before Use

Reading the herbicide label is a very profitable use of your time. Information on the label will direct you to the correct uses, application methods, rates, and potential environmental hazards. Following label directions will result in the best possible control with minimal crop injury and environmental degradation. The label contains restrictions on use and discusses environmental and soil conditions that affect crop injury, influence the effectiveness of weed control, and can cause nontarget site effects.

Do Not Use Any Herbicide Unless the Label States that It Is Cleared for Your Particular Use and Crop

Using a nonregistered pesticide can cause harmful residues in the vegetable crop, which can result in crop seizure and consumer injury. The label also states whether the herbicide is a restricted-use or general-use pesticide. Restricted-use pesticide labels contain a statement that the products are restricted, and that only licensed applicators can buy them and supervise their application.

The information in this circular is current as of the date of publication. Watch for notices of changes in the U.S. Environmental Protection Agency (EPA) registration of herbicides in the *Illinois Vegetable Farmer's Letter* or the *Insect, Weed, and Plant Disease Survey Bulletin*. Contact your county Extension adviser or Vegetable Crops Extension, University of Illinois, 1103 West Dorner Drive, Urbana, Illinois 61801, for subscription information.

Reduced Tillage Systems

Reduced tillage systems are a method to combat soil erosion. Roundup, Gramoxone Super, or Gramoxone Extra can be applied outside the normal growing season to control emerged weeds in reduced tillage systems. Weeds should be growing actively and the application must be made before the crop has emerged. If you are applying Roundup to control perennial weeds, it is recommended that Roundup be applied before disturbing the soil. Once Roundup has been applied, it must be allowed to translocate throughout the perennial weed for several days or incomplete control may result. Follow Roundup label directions carefully for the rates and timing of application. If perennial weeds are not a major problem, you can eliminate early flushes of weeds by applying Roundup, Gramoxone Super, or Gramoxone Extra to all weeds that emerge. Plant the crop with minimal working of the soil. Never apply Roundup, Gramoxone Super, or Gramoxone Extra to an emerged crop because severe crop injury or death will occur.

Roundup, Gramoxone Super, and Gramoxone Extra will control most annual broadleaf and grass weeds. Neither herbicide has any soil residual activity, so other weed control measures will be necessary during the growing season. Gramoxone Super and Gramoxone Extra will also suppress perennials by killing their shoots but should not be expected to control regrowth of perennial weeds from rhizomes or other underground storage organs. Roundup is better for controlling perennials, because it will kill shoots and translocate to destroy underground parts. Roundup will only suppress some particularly hard-to-control perennials such as bindweed, hemp dogbane, and milkweed. To obtain control of these perennials, applications of high rates or repeat applications of Roundup (within label guidelines) or mechanical removal may be necessary.

How to Use Herbicide Tables

Use Table 4 to determine the herbicides that are labeled for use in your crop. Once you have determined the herbicides available for your crop, use Table 5 to determine which of the labeled herbicides will provide control of the weeds you have present.

If you are not certain of the herbicide name, both the common name and the trade names of all herbicides in this circular are listed in Table 6. These tables are not intended to replace careful reading of a current herbicide label. **ALWAYS READ THE LABEL BEFORE APPLYING ANY PESTICIDE.**

HERBICIDE RATES AND GUIDELINES FOR USE IN VEGETABLE CROPS

All herbicide rates given in Table 4 are in amount of product per broadcast acre. Adjust amounts accordingly for banded applications. Preemergence applications should be made before weeds emerge or after removing any weeds present. Postemergence applications should be made after weeds have emerged. Stale seedbed treatments should only be made if weeds have emerged but no crop plants are present.

Re-registration of older herbicides has affected the availability of a number of products. For example, neither Enide nor Amiben will be re-registered; thus, their future availability is questionable and they have been removed from this revision. Some of the older herbicides not listed in this circular may be available and old stocks can still be used.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops

Herbicide	Rate of product per broadcast acre	Remarks
	ASPARAGUS	
Preemergence		
Devrinol (napropamide)	4-6 lb of 50WP	Rainfall or irrigation is necessary for activity. Established beds only.
Karmex, others (diuron)	2-4 lb of 80WP	Do not apply to young plants during the first year. Two applications per year can be made. See label restrictions.
Lexone or Sencor (metribuzin)	1.3-2.5 lb of 75DF	Established beds only.
Princep, others (simazine)	2-4 lb of 80WP	Established beds only.
Sinbar (terbacil)	1.5-3 lb of 80WP	With direct seeded asparagus, spray activated carbon over rows. High organic soils inactivate Sinbar.
Treflan (trifluralin)	1-1.5 pt of 4EC, or 2-4 pt of MTF	See label for incorporation instructions. Established beds only.
Postemergence		
2,4-D amine	See label	Apply to actively growing weeds.
Fusilade 2000 (fluazifop-butyl)	16-48 fl oz of 1EC	NONBEARING ASPARAGUS ONLY. Use crop oil concentrate or a nonionic surfactant. See label for amount..
Poast (sethoxydim)	1.5-2 pt of 1.5EC	NONBEARING ASPARAGUS ONLY. Use crop oil concentrate. See label for amount.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems. Apply at least 1 week before spears emerge, or delay until after harvest.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
	CARROTS	
Preemergence		
Treflan (trifluralin)	1-2 pt of 4EC or MTF	Must be incorporated.
Postemergence		
Fusilade (fluazifop-butyl)	1-1.5 pt of 1EC	Use crop oil concentrate or nonionic surfactant. Up to 2 applications can be made per year.
Linex or Lorax (linuron)	1.5-3 lb of 50DF	Carrots must be at least 3 inches tall. Apply before grasses are 2 inches tall.
Sencor (metribuzin)	0.33 lb of 75DF or 0.5 pt of 4L	See label warnings. Carrots must have at least 5-6 leaves. Weeds must be small.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	COLE CROPS (Broccoli, Brussels Sprout, Cabbage, Cauliflower, and Turnip)	
Preemergence		
Dacthal (DCPA)	8-11 lb of 75WP	Not effective on high organic soils. Can be sprayed directly over transplants.
Devrinol (napropamide)	2-4 lb of 50WP	Can apply to transplants or direct-seeded plants. Should incorporate shallowly.
Goal (oxyfluorfen)	1.25 to 2.5 pt of 1.6EC	Apply to soil after final tillage but before transplanting. May cause foliar injury. Do not apply to brussels sprout.
Treflan (trifluralin)	1-2 pt of 4EC or MTF	Direct-seeded cole crops exhibit marginal tolerance to Treflan. Stunting can occur under stress. Must be incorporated.
Postemergence		
Poast (sethoxydim)	1.5-2 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	CORN (Sweet and Popcorn)	
Preemergence		
AAtrex, others (atrazine)	2-4 lb of 80WP, or 4-6 pt of 4L, or 2.2-3.3 lb of Nine-O	Land treated with atrazine should not be planted with any vegetable the following year or injury may occur.
Bladex (cyanazine)	1.5-6.0 lb of 80WP, or 1.3-5.3 lb of 90DF, or 1.25-4.75 qt of 4L	
Dual (metolachlor)	1.5-3 pt of 8EC, or 6-12 lb of 25G.	Can be incorporated or applied before emergence.
Eradicane Extra (EPTC + safener + extender)	4-8 pt of 6.7EC	Will suppress wild proso millet. Must be incorporated. Contains an extender that may lengthen the period of control.
Genate Plus or Sutan + (butylate + safener)	4.75-7.33 pt of 6.7EC	Especially useful on sandy soils. Must be incorporated.
Lasso (alachlor)	2-4 qt of 4EC	

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
Princep, others (simazine)	3.75-5 lb of 80WP, or 6-8 pt of 4L	Do not plant vegetables the year following application. Do not graze treated area.
Prowl (pendimethalin)	1.5-4 pt of 4EC	Do not incorporate. For use on processing varieties. Do not apply prior to planting.
Postemergence		
AAtrex, others (atrazine)	4-6 pt of 4L, or 2.5-3.75 lb of 80WP, or 2.2-3.3 lb of Nine-O	Can be applied with crop oils. Preemergence applications preferred. See label precautions.
Basagran (bentazon)	1.5-2 pt of 4S	Apply when weeds are small. Consult label for specific directions.
2,4-D amine	See label	Apply to actively growing weeds, preferably before corn is 6 inches tall. See label restrictions. Sweet corn injury may occur.
Stale Seedbed		
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
CUCURBITS (Cucumber, Muskmelon, and Watermelon)		
Preemergence		
Alanap (naptalam)	6-8 qt of 2L	A second application can be made prior to vining. Normally tank mixed with Prefar.
Curbit	3-4.5 pt of 3EC	Read label carefully before using. Avoid using on cool wet soils. Requires signing a waiver before using.
Dacthal (DCPA)	6-14 lb of 75WP	Apply when the crop is at the 4-5 true leaf stage. For use on direct-seeded cucurbits only.
Prefar (bensulide)	5-6 qt of 4EC	Incorporate or irrigate in. Can tank mix with Alanap. Do not plant other than label-specified crops for 18 months after application.
Postemergence		
Poast (sethoxydim)	1.5-2 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
DRY BEANS (White, Navy, Kidney, Pinto, Lima, and Adzuki)		
Preemergence		
Dacthal (DCPA)	8-11 lb of 75WP	
Dual (metolachlor)	1.5-3 pt of 8EC	
Eptam or Genep (EPTC)	2.5-3.5 pt of 7EC	Do not use on adzuki beans, cowpeas, lima beans, or other flat pod beans. Incorporate immediately.
Prowl (pendimethalin)	1-1.5 qt of 4EC	Must be incorporated.
Treflan (trifluralin)	1-2 pt of 4EC or MTF	Must be incorporated.
Postemergence		
Basagran (bentazon)	1.5-2 pt of 4S	Apply when weeds are small. Beans are tolerant after the first trifoliate leaf has expanded.
Stale Seedbed		
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
	EGGPLANT	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Apply 4-6 weeks after transplanting or when direct-seeded plants are 4-6 inches tall. Cultivate if weeds have emerged before applying.
Devrinol (napropamide)	2-4 lb of 50WP	Transplanted eggplant only.
Postemergence		
Poast (sethoxydim)	1-1.5 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
	GREENS (Chicory, Collard, Kale, Mustard, Spinach, Turnip Greens)	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	For use on collards, kale, mustard, and turnip greens. Not effective on high organic matter soils.
Treflan (trifluralin)	1-1.5 pt of 4EC or MTF	Must be incorporated.
Postemergence		
Poast (sethoxydim)	1-1.5 pt of 1.5EC	Spinach or mustard greens only. Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	Collards only. See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	HORSERADISH	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Apply uniformly to soil at planting time.
Stale Seedbed		
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	LETTUCE	
Preemergence		
Balan (benefin)	3-4 qt of 1.5EC	Direct-seeded lettuce only. Must be incorporated.
Kerb (pronamide)	2-4 lb of 50WP	Moisture is necessary to activate. Label rates vary depending on variety.
Prefar (bensulide)	5-6 qt of 4EC	Can be applied to head and leaf lettuce. Must be incorporated.
Postemergence		
Poast (sethoxydim)	1-1.5 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
	OKRA	
Preemergence		
Treflan (trifluralin)	1-2 pt of 4EC or MTF	Must be incorporated immediately after application.
Stale Seedbed		
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	ONION	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Can be applied at planting or at layby. Emerged weeds will not be controlled.
Postemergence		
Buctril (bromoxynil)	0.5-0.75 pt of 4ME	Apply when onions have 2-5 true leaves. Sensitivity of onions is affected by variety and environment.
Goal (oxyfluorfen)	0.6 pt of 2EC	Do not apply until onions have 2 true leaves. Best control achieved when weeds are in the 2-4 leaf stage.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	PEAS	
Preemergence		
Dual (metolachlor)	1.5-3 pt of 8EC	Can be incorporated. See label for restrictions.
Command (clomazone)	1 pt of 4EC	Must be incorporated.
Treflan (trifluralin)	1-1.5 pt of 4EC or MTF	Must be incorporated.
Postemergence		
Basagran (bentazon)	1.5-2 qt of 4S	Apply when weeds are small. Pea injury can occur. See label precautions.
Thistrol (MCPB)	2-6 pt of 2EC	Apply when peas have developed 6-12 nodes and weeds are less than 3 inches tall.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	PEPPER	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Apply 4-6 weeks after transplanting or when direct-seeded plants are 4-6 inches tall.
Devrinol (napropamide)	2-4 lb of 50WP	Can be applied to direct-seeded plants or transplants. Incorporate.
Treflan (trifluralin)	1-2 pt of 4EC or MTF	Incorporate. Apply to transplants only.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
Postemergence		
Poast (sethoxydim)	1.5-2 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
	POTATO	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Apply at planting, drag off, or at layby.
Dual (metolachlor)	1.5-3 pt of 8EC, or 6-12 lb of 25G	Apply preemerge, incorporated, or at layby. Do not use on muck soils.
Eptam or Genep (EPTC)	3.5-7 pt of 7EC	Incorporate immediately after applying. The variety Superior is sensitive.
Lexone or Sencor (metribuzin)	0.6-1.33 lb of 75DF	Make a single application prior to emergence.
Linex or Lorox (linuron)	1.5-2.5 pt of 4L, or 1-4 lb of 50WP or 50DF	Apply after planting but before potato emergence. Plant "seed" 2 inches deep.
Prowl (pendimethalin)	1.5-3 pt of 4EC	Incorporate lightly. Do not use on muck soils.
Treflan (trifluralin)	1-2 pt or 4EC or MTF	Apply after planting and incorporate uniformly.
Postemergence		
Lexone or Sencor (metribuzin)	0.5-1 pt of 4L, or 0.3-0.67 lb of 75DF	Do not use on smooth-skinned white or red-skinned potatoes. Apply only if 3 successive days of sun have occurred prior to application. Apply before weeds are 1 inch tall.
Poast (sethoxydim)	1-1.5 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	PUMPKIN AND SQUASH	
Preemergence		
Command (clomazone)	2 pt of 4EC	Pumpkins only. Requires incorporation. May cause some temporary bleaching of pumpkin plants.
Dacthal (DCPA)	6-14 lb of 75WP	Not effective on soils with greater than 5% organic matter. Use on summer and winter squash only. Apply when plants are well established and have 4-5 leaves.
Prefar (bensulide)	5-6 qt of 4EC	Incorporate or irrigate in. See label restrictions.
Postemergence		
Poast (sethoxydim)	1-1.5 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
	SNAP BEANS OR GREEN BEANS	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Not effective on soils with more than 5% organic matter. Do not feed treated plants to livestock.
Dual (metolachlor)	1.5-3 pt of 8EC	
Eptam or Genep (EPTC)	3.5 pt of 7EC	Do not use on flat-podded beans. Must be incorporated.
Treflan (trifluralin)	1-1.5 pt of 4EC or MTF	Must be incorporated.
Postemergence		
Basagran (bentazon)	1.5-2 pt of 4S	Apply when weeds are small. Beans are tolerant after the first trifoliate has fully expanded. Some injury to beans may occur.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	TABLE BEET	
Preemergence		
Pyramin (pyrazon)	3-3.5 qt of 4.2FL	Rainfall or irrigation is needed for activation.
Ro-Neet (cycloate)	2-2.7 qt of 6EC	Must be incorporated. Use on mineral soils only.
Postemergence		
Pyramin (pyrazon)	3.5 qt of 4.2FL	Timing is very important. Treat when beets have 2 expanded leaves and weeds have 2-4 leaves.
Stale Seedbed		
Roundup (glyphosate)	1.5-3 qt	See discussion of reduced tillage systems.
	TOMATO	
Preemergence		
Dacthal (DCPA)	6-14 lb of 75WP	Apply when direct-seeded plants are established and 4-6 inches tall or when transplanted plants have been established for 4-6 weeks.
Devrinol (napropamide)	2-4 lb of 50WP	Must be incorporated.
Lexone or Sencor (metribuzin)	0.5-1 pt of 4L, or 0.33-0.66 lb of 75DF	Apply to transplanted tomatoes only. May be incorporated.
Prefar (bensulide)	4-5 qt of 4EC	Incorporate or irrigate in. Do not plant other than specified crops for 18 months after treatment.
Tillam (pebulate)	2.66-4 qt of 6EC	Do not use Tillam with row covers.
Treflan (trifluralin)	1-2 pt of 4EC or MTF	Must be incorporated. For direct-seeded plants apply at blocking or thinning as a directed spray between rows.

Table 4. Herbicide Rates and Guidelines for Use in Vegetable Crops (continued)

Herbicide	Rate of product per broadcast acre	Remarks
Postemergence		
Lexone or Sencor (metribuzin)	0.5-0.75 pt of 4L, or 0.33-0.67 lb of 75DF	Plants must be established; see label. Apply only if 3 successive days of sun have occurred prior to application.
Poast (sethoxydim)	1.5-2 pt of 1.5EC	Use crop oil concentrate.
Stale Seedbed		
Gramoxone (paraquat)	1 qt of Super or 2-3 pt of Extra	See discussion of reduced tillage systems.

Table 5. Weed Susceptibility to Herbicides Labeled for Use in Vegetable Crops

Herbicide	Weeds controlled	
	Grasses	Broadleaves
AAtrex, others (atrazine)	barnyardgrass, foxtail, crabgrass, witchgrass	cocklebur, jimsonweed, lambsquarters, mustard, annual morningglory, nightshade, pigweed, purslane, ragweed, velvetleaf
Alanap (naptalam)		carpetweed, chickweed, cocklebur, hairy galinsoga, lambsquarters, purslane, ragweed
Balan (benefin)	annual bluegrass, barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, seedling johnsongrass	carpetweed, chickweed, knotweed, lambsquarters, pigweed, purslane
Basagran (bentazon)		Canada thistle, purslane, lambsquarters, ragweed, galinsoga, jimsonweed, smartweed, velvetleaf, wild mustard, cocklebur
Bladex (cyanazine)	annual bluegrass, barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, witchgrass	carpetweed, cocklebur, chickweed, purslane, morningglory, jimsonweed, lambsquarters, nightshade, pigweed, ragweed, velvetleaf, wild mustard
Buctril (bromoxynil)		mustard, cocklebur, pennycress, jimsonweed, annual morningglory, nightshade, lambsquarters, smartweed, pigweed
Command (clomazone)	barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, seedling johnsongrass	purslane, ragweed, jimsonweed, lambsquarters, smartweed, velvetleaf
Curbit (ethalfluralin)	annual bluegrass, crabgrass, barnyardgrass, foxtail, goosegrass, fall panicum, seedling johnsongrass, shattercane, witchgrass	wild buckwheat, carpetweed, chickweed, lambsquarters, pigweed, nightshade, purslane
2,4-D amine		carpetweed, dandelion, dock, galinsoga, pigweed, jimsonweed, lambsquarters, morningglory, plantain, ragweed, smartweed, thistle, wild mustard
Dacthal (DCPA)	crabgrass, foxtail, barnyardgrass, goosegrass, annual bluegrass, seedling johnsongrass	carpetweed, lambsquarters, common chickweed, purslane
Devrinol (napropamide)	barnyardgrass, weedy brome, crabgrass, foxtail, goosegrass, seedling johnsongrass	chickweed, purslane, common groundsel, prostrate knotweed, lambsquarters, pigweed, prickly lettuce
Dual (metolachlor)	barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, witchgrass, yellow nutsedge	nightshade, carpetweed, galinsoga, pigweed
Eptam or Genep (EPTC)	annual bluegrass, crabgrass, barnyardgrass, foxtail, goosegrass, shattercane, witchgrass	annual morningglory, carpetweed, chickweed, lambsquarters, nightshade, purslane
Eradicane Extra (EPTC + safener + extender)	annual bluegrass, crabgrass, barnyardgrass, goosegrass, seedling johnsongrass, volunteer small grains, foxtail	annual morningglory, nightshade, carpetweed, lambsquarters, purslane, pigweed, velvetleaf

Table 5. Weed Susceptibility to Herbicides Labeled for Use in Vegetable Crops (continued)

Herbicide	Weeds controlled	
	Grasses	Broadleaves
Fusilade 2000 (fluazifop-butyl)	bermudagrass, goosegrass, johnsongrass, wild proso millet, barnyardgrass, fall panicum, foxtail, crabgrass, witchgrass, volunteer cereals	
Genate Plus or Sutan+ (butylate + safener)	barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, shattercane, seedling johnsongrass	
Goal (oxyfluorfen)		eveningprimrose, pigweed, common groundsel, purslane, black nightshade, shepherdspurse
Gramoxone Super or Extra (paraquat)	Most annual grasses and broadleaves.	See discussion of reduced tillage systems.
Karmex, others (diuron)	barnyardgrass, crabgrass, annual bluegrass, foxtail	pigweed, purslane, ragweed, chickweed, mustard, pennycress, velvetleaf
Kerb (pronamide)	barnyardgrass, brome, annual bluegrass, panicum, foxtail, goosegrass, volunteer small grains	carpetweed, chickweed, henbit, knotweed, purslane, lambsquarters, nightshade, morningglory
Lasso, Stall (alachlor)	barnyardgrass, crabgrass, foxtail, goosegrass, fall panicum, witchgrass	carpetweed, pigweed, galinsoga, nightshade, purslane
Lexone or Sencor (metribuzin)	downy brome, crabgrass, foxtail, seedling johnsongrass	pigweed, purslane, ragweed, chickweed, jimsonweed, lambsquarters, pepperweed, shepherdspurse, smartweed, prickly sida
Linex or Lorox (linuron)	barnyardgrass, crabgrass, fall panicum, goosegrass	annual morningglory, carpetweed, groundsel, lambsquarters, mustard, cocklebur, pigweed, prickly sida, purslane, smartweed, velvetleaf
Poast (sethoxydim)	bermudagrass, goosegrass, johnsongrass, quackgrass, wild proso millet, barnyardgrass, fall panicum, foxtail, crabgrass, witchgrass, volunteer cereals	
Prefar (bensulide)	crabgrass, foxtail, fall panicum, goosegrass	
Princep, others (simazine)	annual bluegrass, crabgrass, foxtail, goosegrass, fall panicum, witchgrass	carpetweed, galinsoga, nightshade, pigweed, purslane, annual morningglory, mustard, lambsquarters, groundsel, pepperweed, ragweed, smartweed
Prowl (pendimethalin)	barnyardgrass, crabgrass, fall panicum, foxtail	carpetweed, lambsquarters, pigweed, purslane
Pyramin (pyrazon)		lambsquarters, pigweed, ragweed, shepherdspurse, purslane, nightshade, mustard, henbit, smartweed
Ro-Neet (cycloate)	annual bluegrass, crabgrass, volunteer barley, foxtail, barnyardgrass	nightshade, henbit, lambsquarters, purslane, redroot pigweed, shepherdspurse
Roundup (glyphosate)	Most annual and perennial grasses and broadleaves. See discussion of reduced tillage systems.	
Sinbar (terbacil)	crabgrass, foxtail, seedling johnsongrass, barnyardgrass, annual bluegrass	chickweed, lambsquarters, wild mustard, pepperweed, shepherdspurse, dandelion, knotweed, pigweed, purslane, plantain, ragweed, henbit, jimsonweed
Thistrol (MCPB)		Canada thistle, lambsquarters, pigweed, smartweed, sowthistle, annual morningglory
Tillam (pebulate)	barnyardgrass, crabgrass, foxtail, goosegrass	lambsquarters, pigweed, purslane, shepherdspurse
Treflan (trifluralin)	annual bluegrass, crabgrass, barnyardgrass, foxtail, seedling johnsongrass, goosegrass	carpetweed, chickweed, knotweed, lambsquarters, pigweed, purslane

Table 6. Common and Corresponding Trade Names that Appear in This Circular

Common name	Trade name
alachlor	Lasso
atrazine	AAtrex, others
benefin	Balan
bensulide	Prefar
bentazon	Basagran
bromoxynil	Buctril
butylate + safener	Genate Plus, Sutan +
clomazone	Command
cyanazine	Bladex
cycloate	Ro-Neet
2,4-D amine	several names
DCPA	Dacthal
diuron	Karmex, others
EPTC	Eptam, Genep
EPTC + safener + extender	Eradicane Extra
ethalfluralin	Curbit
fluazifop-butyl	Fusilade
glyphosate	Roundup
linuron	Linex, Lorox
MCPB	Thistrol
metolachlor	Dual
metribuzin	Lexone, Sencor
napropamide	Devrinol
naptalam	Alanap
oxyfluorfen	Goal
paraquat	Gramoxone Super or Extra
pebulate	Tillam
pendimethalin	Prowl
pronamide	Kerb
pyrazon	Pyramin
sethoxydim	Poast
simazine	Princep, others
terbacil	Sinbar
trifluralin	Treflan

Environmental and Health Hazards of Herbicides

Nontargeted effects can occur from the use of herbicides. With the increased attention directed toward nontargeted effects of pesticides, it is very important that you educate yourself about these effects and consider them when designing weed management systems. The following section contains discussions on some of the potential environmental and health hazards of herbicides. This is only an overview. More detailed information is contained in the herbicide label, the *1990 Illinois Pest Control Handbook* (University of Illinois at Urbana-Champaign, Cooperative Extension Service), and 1987, 1988, and 1989 *Proceedings of the Illinois Fruit, Vegetable, and Irrigation Convention* (University of Illinois at Urbana-Champaign, Department of Horticulture).

Environmental Hazards

Adverse environmental effects from herbicides can have long-term consequences which are difficult to correct and must be avoided. Some environmental hazards, such as herbicide drift and carryover, will mainly affect your operation, while other hazards such as water quality, affect all the residents of Illinois. The following section discusses some of the potential hazards and methods to avoid them.

Herbicide Carryover. Herbicide carryover from persistent herbicides has been a particular problem to growers of vegetable crops. Persistence is dependent on herbicide characteristics (i.e., method of degradation, water solubility, and rate of application) and site characteristics (i.e., soil type, rainfall, and temperature). Because correction of carryover problems once they occur is virtually impossible, carryover must be avoided. The most important method to avoid herbicide carryover is to follow label rotation restrictions. Label restrictions should be considered as minimum guidelines. Table 7 summarizes some of the label restrictions. Always refer to the label for specific information. If differences between the table and herbicide label occur, always follow label information. Further information on avoiding vegetable crop injury from herbicide carryover is also contained in recent editions of the *Proceedings of the Illinois Fruit, Vegetable, and Irrigation Convention* (University of Illinois at Urbana-Champaign).

Herbicide drift. Another frequent hazard to vegetable growers is crop injury from herbicide drift. Certain herbicides, if not used correctly, can cause injury to nontarget plants. Herbicides such as Command, dicamba, and 2,4-D can drift up to a mile and cause serious damage to grapes, tomatoes, peppers, other vegetables, fruit trees, and ornamental plants. Before spraying Command, dicamba, or 2,4-D, survey the area for desirable plants. Spray only on calm days and use drift inhibitors when appropriate. Minimize drift by applying herbicides with nozzles that produce large droplets. Use an amine formulation of 2,4-D to reduce vapor drift. Spray Command, dicamba, and 2,4-D when the temperature is expected to be lower than 80-85°F for several days after treatment. Avoid applying Command to wet soils and incorporate Command soon after application.

Spray tank residuals. Dicamba or 2,4-D residues in spray tanks can also injure susceptible vegetable crops. Carefully follow label directions for cleaning spray equipment after using dicamba or 2,4-D. If possible, do not use the same spray equipment to apply 2,4-D or dicamba that you use to apply other pesticides.

Herbicide resistance. There are now more than 50 documented reports worldwide of weeds developing resistance to herbicides. Herbicide resistance tends to occur when a persistent herbicide is used year after year in the same field. Thus, continued use of the same herbicide on a perennial crop such as asparagus should be avoided. Many of the resistant problems have occurred with triazine herbicides such

Table 7. Label Restrictions (in Months) on Rotating to Vegetable Crops

AT = herbicide labeled for the crop or no rotation restriction exists, NY = the crop can be planted the year after application, NNY = the crop cannot be planted the following year, and FB = a field bioassay required before planting the crop.

	Crop						
Herbicide	Tomato	Pea	Snap Beans	Sweet Corn	Pumpkin	Melon	Cole Crops
Soybean Herbicides							
Canopy	FB[1]	FB	FB	18	FB	FB	FB
Classic	FB	FB	FB	FB	FB	FB	FB
Command	NNY	AT	9	9	AT	9	NNY
Commence	NNY	9	9	9	9	9	NNY
Dual	18	AT	AT	AT	18	18	18
Lexone or Sencor	4-10	4-10	12	12	12	12	12
Lorox	NNY	NNY	NNY	4	NNY	NNY	NNY
Lorox Plus	FB	FB	FB	FB	FB	FB	FB
Preview	FB	FB	FB	FB	FB	FB	FB
Prowl	NY	NY	NY	AT[2]	NY	NY	NY
Pursuit	18	9.5	9.5	18	18	18	18
Reflex	18	18	18	10	18	18	18
Salute	4	8	12	4	12	12	12
Scepter	18	18	11	18	18	18	18
Squadron	18	18	11	18	18	18	18
Tri-Scept	18	18	11	18	18	18	18
Tackle or Blazer	8	8	8	8	8	8	8
Tornado	18	18	18	10	18	18	18
Treflan	AT[3]	AT	AT	5	5	5	AT
Turbo	12	8	8	12	8	12	12
Corn Herbicides							
AAtrex and others	NNY	NNY	NNY	AT	NNY	NNY	NNY
Bicep	18	18	18	AT	18	18	18
Bladex	NY	NY	NY	AT	NY	NY	NY
Conquest	18	18	18	AT	18	18	18
Lariat	NNY	NNY	NNY	AT	NNY	NNY	NNY
Princep	NNY	NNY	NNY	AT	NNY	NNY	NNY
Prozine	NNY	NNY	NNY	AT	NNY	NNY	NNY
Sutazine	18	18	18	AT	18	18	18

[1] The rotation restrictions are in months after application.
[2] Sweet corn for processing only.
[3] Transplanted tomatoes only.

as simazine and atrazine. The labels of those herbicides contain information about avoiding resistance problems.

Approaches to avoid herbicide resistance combine herbicides and mechanical (cultivation) and cultural (crop rotation) weed management practices. Rotate between or use tank mixes of herbicides with different mechanisms of killing the plant. For example, in asparagus rotate between Princep and Treflan. Use tillage to control weeds that escaped from herbicide applications. Especially important in minimizing any weed resistance that does occur is to scout your fields, paying special attention to any patches of a weed normally controlled by the herbicide.

Water quality. Residues of some herbicides such as atrazine, metolachlor, alachlor, cyanazine, and metribuzin have been found in surface and/or groundwater. The levels detected have normally been low, but contamination of water resources is a growing concern. For example, groundwater contamination from pesticides and nitrates is a particular concern in areas of the state with sandy soils and shallow groundwater.

Factors determining the potential for groundwater and surface water contamination include herbicide solubility in water, rate of degradation, volatility, and tendency for the herbicide to attach to soil particles or organic matter. Herbicides which have high water solubility and long persistence are a particular concern.

Site characteristics (soil type, soil depth, water table depth, slope, and weather) also can lead to contamination of water resources from herbicides. You should be aware of the potential problem of herbicide contamination and take all possible steps to avoid contamination of surface and subsurface water resources.

Disposing of herbicides and containers. *Surplus herbicides.* If possible use surplus herbicide mixtures by applying them to labeled crops that have the same weed problems. Never drain surplus pesticides in any location where they can contaminate ground or surface water supplies. Avoid creating surplus tank mixes

by accurately measuring the treatment area and mixing the correct amount of pesticide. If a large amount of surplus pesticide is generated, contact the Illinois EPA Division of Land Pollution Control for instructions about disposal.

Pesticide containers. All empty containers, regardless of their type, should be rinsed three times before disposal. Rinse-water should be dumped into the tank. Triple-rinsed containers should be punctured or broken to facilitate drainage and to prevent reuse for any purpose. Containers should then be disposed of according to label directions and local regulations, with regard for the protection of water resources.

Health Hazards

Health hazards from exposure to pesticides can be divided into acute or chronic effects according to the duration and amount of exposure.

Acute effects. Acute effects or poisoning occur soon after exposure to large amounts of a pesticide. These types of effects are dangerous to you, your family, and your workers. The potential for human or animal poisoning from pesticides can be reduced by carefully storing and handling pesticides. Keep pesticides in a separate area, room, or building used only for storage purposes. The storage area should be dry and ventilated. Keep all entrances to the area locked at all times to protect children, other people, and animals. **CAUTION:** Do not store herbicides together with insecticides. Remove only the pesticide that will be used in one day, and after use return the pesticide to the storage area. **FOLLOW LABEL DIRECTIONS WHEN HANDLING PESTICIDES.** Pay particular attention to sections on protective clothing requirements and any field reentry limitations.

Herbicide residues in vegetables. The issue of pesticide residues in vegetables is currently receiving intense public attention. Many of the herbicides used in vegetable crops are older products and were registered before current toxological and environmental standards were established by the EPA. Congress has required the EPA to re-register these older products to bring the data up to current toxological and environmental standards. This re-registration has caused some companies to remove products from the market.

Data exists that some herbicides (and other pesticides) can potentially cause adverse health effects, such as cancer from chronic (long-term) exposure. There is controversy about the reliability and importance of this data. Groups that are particularly concerned about pesticide residues in vegetables include the National Resource Defense Council; National Coalition Against Misuse of Pesticides; and Americans for Safe Food. Because customers will question you, it is recommended that you stay up-to-date on this issue. The above groups have information reflecting their views. Information is available reflecting food industry views from such groups as The Alliance for Food and Fiber, Food Marketing Institute, and Center for Produce Quality. Recent editions of the *Proceedings of Illinois Fruit, Vegetable, and Irrigation Convention* also have articles on pesticide residues in vegetables.

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